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(54) SUB-ORBITAL, HIGH ALTITUDE COMMUNICATIONS SYSTEM

SUB-ORBITAL MIT GRÖSSERER HÖHE KOMMUNIKATIONSANORDNUNG

SYSTEME DE COMMUNICATIONS SOUS-ORBITAL DE HAUTE ALTITUDE

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(73) Proprietor: **INTERNATIONAL MULTI-MEDIA CORPORATION**
Narberth PA 19072 (US)

(72) Inventors:
- **SELIGSOHN, Sherwin, I.**
  Narberth, PA 19072 (US)
- **SELIGSOHN, Scott**
  Bala Cynwyd, PA 19004 (US)

(74) Representative: **W.P. THOMPSON & CO.**
Eastcheap House
Central Approach
Letchworth, Hertfordshire SG6 3DS (GB)

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Description

Field of Invention:

[0001] This invention relates to a long duration, high altitude communication system, and more particularly to a communications system in a sub-orbital plane that is well above any system which is physically connected to the ground, and whose components can stay aloft and on station for long periods. The invention is concerned with a telecommunications system according to the preamble of claim 1, a method according to the preamble of claim 23 and a relay station according to the preamble of claim 48.

Background of the Invention:

[0002] Wireless telecommunications systems currently use either terrestrial (ground) based infrastructures or space (satellite) based infrastructures. Terrestrial based systems include radio towers and antennae on tall buildings, mountains, and the like. Also, balloons that are tethered to the ground have been used. Space based systems rely on satellites having telecommunications equipment.

[0003] Terrestrial based wireless telecommunications systems have been known since the early days of radio, almost a hundred years ago. Their configurations range from simple one-way and two-way radio hookups - to radio and television broadcast networks - to today's sophisticated cellular networks and proposed personal communications networks (PCN).

[0004] "Relay stations" are used to send and receive radio transmissions to and from other locations. Because they are on or close to the ground, their radio signals tend on the average to be closer to the horizontal than the vertical. Thus, each relay station can only send and receive signals from a limited distance. The distance that the radio signals can travel is limited because of horizon problems due to the curvature of the earth; line of sight problems due to uneven terrain, trees, and buildings; interference due to other signals or with reflections of the transmitted signal; and attenuation problems due to unwanted absorption of the transmitted signal. To increase the area of coverage, either more powerful equipment must be used, and/or the height of the relay stations must be increased. Increasing power helps to solve the attenuation problem and the interference with other signals problem; but it does not address the horizion, line-of-sight, and interference with reflected signal problems. Therefore, it is preferred to increse the height of the relay stations as by putting them on towers, tall buildings and mountain tops. This rolls back the horizon and line-of-sight for the relay station thereby increasing the area that it can cover, and to some extent reduces the attenuation problem and the interference with the reflected signal problem. However, it is not always feasible to place relay stations at optimum locations due to geographic or political factors, or merely because of the inability to obtain permission from a land owner or government.

[0005] To some extent these problems are alleviated by wireless telecommunications equipment carried by tethered balloons. However, tethered balloons have their own problems. If the balloons are tethered at low altitudes, their area of coverage will not be any larger than that of a relay station on a tower or tall building making it difficult to justify their cost. Also, since they will be subject to the weather and wind conditions that exist at these altitudes, they are likely to be easily damaged and require frequent replacement.

[0006] On the other hand, if they are tethered at altitudes that enable them to relay telecommunications signals over a large enough area to make them economically feasible and to avoid weather conditions, thereby prolonging their life, both the balloons and tethers become hazardous to aircraft and the tethers remain subject to the stress of weather conditions.

[0007] Further, it is likely that the tether of a failed balloon will be strewn along hundreds if not thousands or tens of thousands of feet causing damage and risk of injury to property and persons. Additionally, if the tether falls across electric lines there is a risk of fire and power outages.

[0008] Accordingly, these disadvantages make tethered ballons unsuitable for use as part of a telecommunications system whose components are to operate for long periods.

[0009] To overcome many of the limitations of ground based wireless telecommunications systems, orbital space based telecommunications systems have been constructed using satellite technologies which have evolved since the first days of Sputnik (1957). Satellite systems in geosynchronous orbit (approximately 22,000 miles) have been used for may years with a high degree of reliability. Their prime advantage is their high altitude which enables one satellite to send and receive signals from an area on the earth encompassing hundreds of thousands of square miles. However, satellites are expensive to manufacture, launch and position, either initially or as replacements. Further, because of the cost associated with their manufacture and launch, and the great difficulty in servicing them, extraordinary care must be taken to assure their reliability.

[0010] Moreover, because of a satellite's high altitude, there is a delay in radio transmission of about 1/8 of a second in each direction. This significantly limits the satellite's ability to carry and conduct familiar two way (duplex) voice communications. Also, due to its high altitude, its radio transmission equipment requires more power than required by comparable terrestrial systems. This raises costs and affects the size and weight of equipment both on the satellite and on the ground.

[0011] When a satellite fails, as assuredly they all must do, either electronically, or by decay of orbit, attempts to recover or repair them are extremely expen-

sive. Further, the attempts, whether or not successful, subject personnel and equipment to the risk of injury or loss. On the other hand, a failed satellite may be left in orbit. It will be another piece of "space junk," until its orbit decays to the extent that it plunges through the atmosphere toward earth. If it is not fully consumed during the plunge, it may cause damage to persons or property when it strikes the earth.

[0012] In an attempt to solve the problems attendant to existing high altitude satellite systems, it has been proposed to orbit the satellites at an altitude of either about 500 miles or at about 5,000 miles. While this will reduce power requirements and transmission delay times, it creates other problems. This is because at these lower altitudes the satellites are not geosynchronous. Therefore, telecommunications signals may be required to be transmitted between several satellites during a particular communication. This is because the circumferential position of each satellite relative to the earth is continuously changing. Therefore, a particular satellite that is over a ground station at the beginning of a communication may orbit to such an extent during the communication that it loses the signal from the ground. To maintain the connection, the signal from the ground will have to be transferred to another satellite that is closer to the ground station. Also, the satellites will have to be programmed to permit this to happen. Thus, very complex routing features will need to be implemented. In addition, members of the industry disagree amongst themselves over optimum altitudes, angles of signal propagation, and how to deal with the doppler shifts. Furthermore, because of their lower altitude, the satellites' orbits will decay at faster rates than the higher altitude satellites so that they and the equipment they carry will need to be replaced more often, again incurring substantial expense.

[0013] GB-A-2082995 describes a lightweight airborne device which is adapted to maintain a position in the upper atmosphere and to act as a communication relay station. The device includes means to generate lift, drawing power from its environment, for example using solar cells.

[0014] FR-A-2282366 describes a method of destroying a balloon by remote control, with the load returning to earth by the use of a parachute.

[0015] EP-A-0371529 describes a balloon in which the temperature of the gas is controlled by the amount of solar energy that enters the balloon.

[0016] The problems described could be substantially reduced by a telecommunications infrastructure using long duration, high altitude, recoverable telecommunications stations that can be kept on station and which are located in a sub-orbital plane, and which have the ability to receive telecommunication signals from a ground station and relay them to another similar station or to a further ground station.

[0017] Since the propagation of radio signals to and from the relay stations would be nearly vertical; line of sight, reflective interference and attenuation problems would be minimized. This is because there would be less likelihood of tall buildings, trees or terrain to block, reflect, or absorb the radio signals. This means that less power would be needed to send a signal a given distance than if it were transmitted horizontally at or near the ground. Further, because the system would operate at altitudes that are less than ten percent of the lowest proposed satellite systems, less power would be required for telecommunications signals with no noticeable delay in transmission.

[0018] This will create a means for providing relatively low cost, efficient, wireless telecommunications without incurring the economic and physical limitations associated with terrestrial based network infrastructures, tethered balloon systems or orbiting space-based network infrastructures.

Summary of the Invention:

[0019] The objects of the invention are achieved by the system of claim 1, the method of claim 23 and the relay station of claim 48.

[0020] Accordingly, with the aforesaid in mind the invention relates generally to a telecommunications system that comprises at least two ground stations. Each of the ground stations includes means for sending and means for receiving telecommunication signals. At least one relay station is provided. The relay station includes means for receiving and sending telecommunication signals from and to the ground stations and from and to other relay stations.

[0021] The relay stations are at an altitude of about 19 to 56 km (12 to 35 miles). Means are provided for controlling the lateral movement of the relay stations so that a predetermined altitude and a predetermined location of each of the relay stations can be achieved and maintained.

[0022] In another aspect the invention relates to a telecommunications method comprising the steps of providing at least two ground stations and at least one relay station. One of the relay stations is positioned at a predetermined location and at an altitude of about 19 to 56 km (12 to 35 miles). A telecommunications signal is transmitted from one of the ground stations to one of the relay stations. The relay station then transmits the telecommunications signal to the second ground station or to at least another of the relay stations and then to the second ground station. Each of the relay stations is maintained at a predetermined altitude and location.

[0023] In still another aspect the invention relates to a relay station for a high altitude sub-orbital telecommunications system, It includes means for receiving and sending telecommunications signals from and to ground stations and/or from and to other relay stations. It also includes means for controlling the lateral and vertical movement of said relay station so that a predetermined altitude and location for the relay station can be

achieved and maintained.

Description of the Drawing:

[0024] The invention can be further understood by referring to the accompanying drawing of a presently preferred form thereof, and wherein

[0025] Figure 1 is a schematic showing a communications system constructed in accordance with a presently preferred form of the invention.

[0026] Figure 2 is a elevation view of one of the relay stations comprising the invention.

[0027] Figure 3 is a view of a portion of Figure 2 showing a propulsion system.

[0028] Figure 4 is a view of a portion of Figure 2 showing another form of propulsion system.

[0029] Figures 5A and 5B are a plan view and an elevation view, respectively, of another form of a part of the invention shown in Figure 2.

[0030] Figure 6A, 6B and 6C are views of further forms of a part of the invention shown in Figure 2.

[0031] Figures 7A and 7B are schematics showing an alternate arrangement of the communications system illustrated in Figure 1.

[0032] Figure 8 is a view of a portion of a relay station.

[0033] Figure 9 is a view of a second embodiment of the portion of the relay station shown in Figure 8.

[0034] Figure 10 is a view of a relay station being recovered.

Description of a Preferred Embodiment:

[0035] Referring now to Figure 1, the system 10 comprises a ground based portion 12 and an air based portion 14.

[0036] The ground based portion 12 may comprise conventional telephone networks 16 with branches that are connected to a ground station 18 having suitable long distance transmitting and receiving means such as antenna 20. The ground based portion 12 may also comprise mobile telephones of well known types such as cellular telephones that may be carried by individuals 22 or in vehicles 24. The antennae 20 are operative to transmit and receive telecommunication signals to and from a sub-orbital, high altitude relay station 28 which is located at an altitude of between about 12 to 35 miles.

[0037] Preferably, there are a plurality of relay stations 28; each one being on station at a fixed location over the earth. As presently preferred, the relay stations are designed to stay aloft and on station at least 20 to 30 days.

[0038] Each relay station 28 contains means for receiving telecommunication signals from a ground station 20, individual 22 or vehicle 24 and then transmitting them to another ground station 118, individual 122 or vehicle 124 either directly or by way of another relay station 130. Once the signals return to the ground based portion 12 of the system 10, the telecommunication calls are completed in a conventional manner.

[0039] The relay station 28 may comprise a lifting device 32.

[0040] While ordinary zero pressure balloons have been considered as suitable lifting devices for high altitude flights, they are not suitable for systems that must operate for periods longer than about a week or ten days. This is because as the gas in a zero pressure balloon cools each night, its density increases. As a result, it descends until it reaches a density altitude that is equal to its own density. Therefore, to remain aloft the zero pressure balloon must drop about 8 - 9% of its weight each night to compensate for its increased density or it may strike the earth.

[0041] A suitable lifting device could be an inflatable, lighter than air device such as a high altitude super-pressure balloon of the type developed by Winzen International, Inc. of San Antonio, Texas. The super-pressure balloon 32 is configured so that it floats at a predetermined density altitude. The configuring is accomplished by balancing inflation pressure of the balloon and the weight of its payload against the expected air pressure and ambient temperatures at the desired density altitude. It has been observed that devices of this character maintain a high degree of vertical stability during the diurnal passage notwithstanding that they are subject to high degrees of temperature fluctuation.

[0042] In the alternative the lifting device 32 could be an improved zero pressure balloon of the type having means for controlling the extent to which the gas inside the balloon is heated during the day and is cooled at night. Thus, controlling the heat of the gas reduces the amount of ballast that will need to be dropped each night.

[0043] As a further alternative, the lifting device 32 could be an overpressure zero pressure balloon. This is a conventional zero pressure balloon that is modified by closing its vents. It is allowed to pressurize within established limits in flight by the controlled release of gas through a valve. This reduces the amount of ballast that must be dropped when the gas cools at night as when a conventional zero pressure balloon would increase in density and lose altitude.

[0044] While the overpressure zero pressure balloon still experiences diurnal altitude changes, it requires significantly less ballast and gas loss than the zero pressure balloon with the heat control. Therefore, flight time and payload may be substaintially greater than for zero pressure balloons. However, the expansion and contraction of the gas inside the balloon during a twenty-four hour period that accompany altitude changes places enormous stress on it so that the payload that it carries is reduced.

[0045] Therefore, it is desirable to control the altitude of the balloon and the expansion and contraction of the gases inside it so that the stresses on it are reduced. This can be accomplished by using a means for controlling the amount that the gas inside the balloon is heated

during the day and is cooled at night. Thus, to the extent that the stress on the balloon can be controlled, payloads of up to three to four tons can be carried for relatively long periods.

[0046] The amount of heat inside the balloon can be controlled by making the skin of the balloon, or portions of the skin, from a suitable transparent, electro-chromatic or photo-chromatic material. Thus, the balloon skin will be substantially transparent at low light levels and at night. This will permit radiant heat energy to enter the balloon and heat its interior in a manner similar to a greenhouse. During the day, sunlight or a signal sent from the ground will cause the skin to become reflective or opaque. This will reduce the amount of radiant energy that will enter the balloon, thereby keeping the interior of the balloon relatively cool.

[0047] Another way to control altitude is to use a balloon that includes a central expansible chamber that is filled with a lighter that air gas that is surrounded by an outer substantially non-expansible chamber that is filled with air. To reduce altitude, compressed air is forced into the outer chamber; to increase altitude, air is vented from the outer chamber. Typical of this system is the Odyssey balloon project of Albuquerque, New Mexico and described in the New York Times of June 7, 1994, at section C, page 1.

[0048] A plurality of tracking stations 36 are provided. They include well known means which can identify a particular relay station 28 without regard to whether it is in a cluster and detect its location and altitude.

[0049] As will be explained, a thrust system is provided for returning a relay station 28 to its preassigned station should a tracking station 36 detect that it has shifted. The thrust system can be operated automatically to keep the relay stations on station by using control systems that rely on fuzzy logic.

[0050] Referring to Figure 2, it can be seen that each of the relay stations 28 comprises one equipment module 38. In a presently preferred form of the invention, the equipment module comprises a platform. However, the equipment module 38 can be of any convenient shape and size that is sufficient to support the equipment necessary to accomplish the purpose of the relay station.

[0051] As seen in Figures 2 and 3 the equipment module 38 includes a housing 40 which is supported by device 32. The housing 40 contains a telecommunication signal transmitter and receiver 44 and a ground link antenna 48. Antenna 48 is for receiving and sending telecommunications signals between ground stations 20 and the relay station 28. The relay station 28 also includes a plurality of antennas 52 which are adapted to receive and transmit telecommunications signals from and to other relay stations. The housing 40 also contains a guidance module 56 that transmits the identity and location of the relay station to the tracking stations 36. It receives instructions from the tracking station for energizing the thrust system. A guidance antenna 58 is provided to enable communication between the tracking station 36 and the guidance module 56.

[0052] A suitable re-energizable power supply 60 is mounted on housing 40, the power supply 60 may comprise a plurality of solar panels 64. In a well known manner the solar panels capture the sun's light and convert it into electricity which can be used by the telecommunications equipment as well as for guidance and propulsion.

[0053] In addition the power supply could also comprise a plurality of wind vanes 68. The wind vanes may be arranged to face in different directions so that at least some of them are always facing the prevailing winds. The wind vanes 68 can be used to generate electric power in a well known manner which also can be used by the telecommunication equipment as well as for guidance and propulsion.

[0054] As seen in Figure 4, an alternate power supply 66 may be provided in the form of a microwave energy system similar to that which has been developed by Endosat, Inc. of Rockville, Maryland. The microwave energy system includes a ground based microwave generator (not shown) that creates a microwave energy beam of about 35 GHz. This beam is directed to receptors 80 on the relay station 28 and there converted to direct current. Further, the microwave energy could come from a source that is in orbit or from free space.

[0055] In a manner similar to the solar energy system, the microwave energy system could supply power sufficient to operate the telecommunications system on the relay station as well as provide power for guidance and propulsion.

[0056] Further, the relay stations 28 may be provided with at least one microwave transmitter and suitable means for aiming the microwave transmitter at a microwave receiving means on another relay station 28 so that a source other than the ground based microwave generator is available to provide microwave energy to the relay stations.

[0057] As seen in Figures 3 and 4 the thrust system for the relay station 28 may comprise a plurality of rockets or jets 90 or propellers 94. The jets 90 and propellers 94 are arranged in a horizontal plane along mutually perpendicular axes which are supported by pods 100 on the housing 40. By selective energizate ion of various ones of the jets or propellers the relay station 28 can be directed to and maintained at a pre-determined location over the earth.

[0058] If desired, additional jets or rockets 108 or propellers 112 could be located on vertical axes to assist in bringing the relay station to its pre-determined altitude on launch or restoring it should its drift from that altitude be more than an acceptable amount.

[0059] Drifting of the relay stations 28 from their predetermined locations will be detected by the tracking stations 36. The tracking stations 36 will then energize the thrust members on the relay stations 28 for selected intervals to return them to their pre-determined locations.

[0060] As an alternative, as seen in Figures 5A and 5B each relay station 28 can comprise a cluster of between two and four sections 34. Each section 34 comprises an equipment module 38 that is independently carried by its own lifting device 32.

[0061] Some of the equipment modules 38 can carry telecommunications equipment while other equipment modules 38 can carry power generation and transmitting equipment. Thus, energy can be transmitted from the power generation modules by beaming microwave energy to antennae on the communications modules. Since there are several sections 34 comprising a relay station, each section 34 can be smaller and lighter than if there were only one equipment module comprising the relay station 28. Further, the provision of a cluster of sections 34 creates a redundancy that will keep the relay station in service should the equipment on one of the sections 34 fail.

[0062] As another alternative, as seen in Figures 6A, 6B and 6C, lightweight, unmanned airplanes 114 could be used in lieu of the balloons. The airplanes 114 could be controlled from the ground in a well known manner. However, they are less desirable than balloons. This is because they are constantly changing position to remain aloft, and because their payloads are limited by the lightweight airframes required to reach high altitudes.

[0063] As seen in Figure 6A power to maintain the airplanes 114 aloft for long periods could be achieved by using solar power. In this instance the airplane could be essentially a flying wing that is comprised of high efficiency solar panels 116. The solar panels in the wing could drive electric motors and an energy storage system.

[0064] Additionally, as seen in Figure 6B hydrogen - oxygen regenerative fuel cells 118 could be used to achieve long periods of flight.

[0065] Further, as seen in Figure 6C the lightweight airplane 114 could achieve its power from microwave energy that is beamed to antennae 126 on the airplane from a transmitting dish 128 on the ground as described above, or is collected from microwave energy in free space.

[0066] When the system 10 is operating the customer will be unaware of its existence. Thus, when a call is placed, the telecommunications signal will be conveyed from the caller's telephone by way of a conventional network to the ground station 18 associated with that location. The microwave antenna 20 will then beam a telecommunications signal corresponding to that telephone call to the nearest relay station 28. Switching circuity of a well known type will direct the signal to another ground station 120 near the recipient. If the recipient is further, the signal will be sent to a further relay station 130 from which it will be directed to a mobile telephone carried by an individual 122 or in a vehicle 124 or to a ground station 140 near the recipient, The signal received by the ground station 120 or 140 will be transmitted to the recipient's telephone by way of a conventional telephone network. Once a communication link is established between two telephones by way of the ground stations and relay stations, the parties can communicate.

[0067] Since the relay stations are at an altitude of about 12 - 35 miles they are above adverse weather. None-the-less, at that altitude telecommunications power requirements are low enough to enable the use of frequencies that are the same as those used for terrestrial transmission. This means that existing allocated telecommunications frequencies can be used. Since much of the engineering has been done for those telecommunications frequencies, the costs of implementing this system are reduced. Further, maximum use of the existing frequencies can be achieved by currently known digital multiple access technologies such as frequency division multiple access (FDMA), time division multiple access (TDMA), code division multiple access (CDMA) or combinations of them.

[0068] Therefore, by comparison to telecommunications signals from satellites, the signals generated in the communications system of the invention can be relatively weak since they travel a snorter distance. This is particularly advantageous since the ability to use a weaker signal results in transmitters and receivers that are smaller, lighter, and which require less power to operate.

[0069] This aspect of the telecommunications system could be enhanced by having the relay stations 28 stationed over more densely populated areas 132 operate at lower altitudes and/or with more narrowly focused angles of reception and propagation 142 than other relay stations 28 that are over less densely populated areas 134 that will operate at higher altitudes and/or with broadly focused angles of reception and propagation 144 as seen in Figures 7A and 7B. By doing this, a substantial unbalance in the volume of traffic handled by the various relay stations comprising the telecommunications system can be reduced. Further, as explained earlier, the relay stations 28 that are designated for the more densely populated areas 132 may operate with lower power. This can result in a lower cost of operation. This is another advantage over a satellite based system since in such a system a reduction in the height of the orbit for a particular satellite will increase its decay rate and shorten its life.

[0070] As best seen in Figures 2, 8, 9 and 10 a recovery system 150 for the relay stations 28 is provided. As will be more fully explained, the recovery system includes a deflation device 152 and a remote controlled recovery parachute 154.

[0071] Referring to Figures 2 and 3 one embodiment of the deflation device 152 includes a housing 160 that is formed integrally with the suitable lighter than air device 32. The housing 160 includes an outwardly extending and radially directed flange 164 that is integrally connected to the device 32 as by welding or by adhesive. The flange 164 supports a downwardly directed, and generally cylindrical wall 168 that supports a bottom wall

172. As seen in Figure 8, the bottom wall 172 is defined by an open lattice so that the housing 160 is connected to the interior of the device 32 and is at the same pressure.

[0072] Near its upper end the cylindrical wall 168 supports an inwardly directed flange 176. A frangible cover 184 is connected to the flange in airtight relation. This can be accomplished by connecting the cover to the flange by an adhesive, or with a suitable gasket between them, or by fabricating the cover as an integral part of the housing 160.

[0073] The cylindrical wall 168, bottom wall 172 and cover 184 define a chamber that contains the remote control recovery parachute 154.

[0074] A small chamber 190 is formed on the underside of the cover 184 by a wall 192. A small explosive pack 194 which is contained within the chamber 190 is responsive to a signal received by antenna 196.

[0075] The parachute 154 has its control lines 198 connected to a radio controlled drive member 200 that is contained within the housing 160. The drive member 200 may include electric motors that are driven in response to signals from the ground to vary the length of the control lines in a well known manner to thereby provide directional control to the parachute.

[0076] To recover the relay station a coded signal is sent to the device where it is received by antenna 196. This results in the explosive charge 194 being detonated and the frangible cover 184 being removed.

[0077] Since the cover 184 is designed to break, the explosive charge can be relatively light so that it does not damage the parachute 154.

[0078] In this regard the wall 192 helps to direct the explosive force upwardly against the cover rather than toward the device 32.

[0079] After the cover has been removed, the gases will begin to escape from the interior of the device 32 through bottom wall 172 and the opening in the top of the housing. The force of air exiting from the device 32 when the cover is first removed will be sufficient to deploy the parachute.

[0080] As seen in Figure 10 the parachute 154 will support the device 32 by way of its control lines 198. As explained above, the relay station 28 can be directed to a predetermined location on the ground.

[0081] In the embodiment shown in Figure 9 flange 164 supports cover 204 with an annular airtight gasket between them. The cover 204 is held against the flange 164 by a plurality of circumferentially spaced clamping brackets 210. The clamping brackets are retractably held in engagement with the cover 204 by electrically driven motors 212. The motors are energized in response to signals from the ground to retract the brackets 210.

[0082] When the brackets 210 are retracted, the pressure of the gases escaping from the device 32 will dislodge the cover and permit the parachute to be deployed.

[0083] After the relay station has been serviced, the recovery system 150 can be replaced and the device 32 can be re-inflated and returned to their respective stations.

[0084] If the relay stations comprise remotely controlled airplanes 114, they can be recovered in a well known manner for servicing and returned to their respective stations.

[0085] While the invention has been described with regard to particular embodiments, it is apparent that other embodiments will be obvious to those skilled in the art in light of the foregoing description. Thus, the scope of the invention should not be limited by the description, but rather, by the scope of the appended claims.

Claims

1. A telecommunications system (10) comprising:

at least two ground stations (18, 120, 140), each of said ground stations including means (20, 36, 118, 128) for sending and receiving telecommunications signals,

at least one relay station (28, 130, 114), the or each said relay station including means for receiving and sending telecommunications signals from and to said ground stations and from and to the other or others of said relay stations,

said at least one relay station (28, 130, 114) being at a predetermined altitude for transmitting and receiving telecommunications signals from and to said ground stations and from and to the other or others of said relay stations,

and means (90, 94, 108, 112) on said at least one relay station for controlling the vertical movement of said relay station or stations so that said predetermined altitude is achieved and maintained, characterised in that said predetermined altitude is between about 19 and 56 km (12 and 35 miles), said controlling means (90, 94, 108, 112) also controls lateral movement of said at least one relay station, and

said means for controlling the vertical and lateral movement of said at least one relay station so that said predetermined altitude and a predetermined location of said at least one relay station are achieved and maintained comprises

(i) first means operative to selectively or simultaneously identify the current altitude or location of said at least one relay station.

(ii) second means operative to selectively or simultaneously identify said predetermined altitude or location for said at least one relay station,

and (iii) means for moving said at least one relay station from said current altitude or lo-

cation to said predetermined altitude or location.

2. A system as defined in claim 1, characterised in that said means for controlling said at least one relay station at said predetermined altitude or location comprises a thrust system (90, 108, 112), and

means are provided for selectively energizing said thrust system.

3. A system as defined in claim 1, characterised in that said means for controlling the vertical and lateral movement of said relay station or stations so that said predetermined altitude and location of said relay station or stations are achieved and maintained comprises

first means operative to selectively or simultaneously identify the current altitude and location of said at least one relay station,
second means operative to selectively or simultaneously identify a predetermined altitude and location of said at least one relay station,
and means for moving said at least one relay station from said current altitude and location to said predetermined altitude and/or location.

4. A system as defined in claim 3, characterised in that

said means for controlling said at least one relay station at said predetermined altitude and location comprises a thrust system (90, 108, 112), and
means are provided for selectively energizing said thrust system.

5. A system as defined in claim 1 including a

a ground-based telecommunications network (16), and wherein at least one of said ground stations is connected to said telecommunications network.

6. A system as defined in claim 1, characterised in that

at least one of said ground stations is mobile (22, 24, 122).

7. A system as defined in claim 1, 2 or 3, characterised in that

said at least one relay station is lighter than air.

8. A system as defined in claim 7, characterised in that

said means for controlling said lateral movement comprises a thrust system, and
electric means are provided for driving said thrust system.

9. A system as defined in claim 7, characterised in that said at least one relay station comprises an inflatable device (32), and

means (152) are connected to said inflatable device for deflating it while it is aloft.

10. A system as defined in claim 9, characterised in that

said means for deflating said inflatable device is operative in response to a signal from a remote source.

11. A system as defined in claim 9, characterised in that

said inflatable device includes a parachute (154) having control lines (198) for controlling its descent when it is recovered.

12. A system as defined in claim 1, characterised in that

said at least one relay station comprises a balloon (32).

13. A system as defined in claim 12, characterised in that

said balloon includes means for controlling its altitude.

14. A system as defined in claim 12, characterised in that

said balloon includes means for controlling the temperature of the gas that it contains.

15. A system as defined in claim 12, characterised in that

said balloon includes a skin, and
at least a portion of said skin is comprised of electro-chromatic material.

16. A system as defined in claim 12, characterised in that

said balloon includes a skin, and
at least a portion of said skin is comprised of photo-chromatic material.

17. A system as defined in claim 1 with at least three relay stations, characterised in that

some of said relay stations comprise a plurality of sections (34),

at least one of said sections including means for selectively receiving and sending telecommunications signals from and to said ground stations and/or others of said relay stations, and
at least one of said sections including means for providing energy for said means for receiving and sending telecommunications signals and/or said means for controlling the lateral and vertical movement of said relay stations.

18. A system as defined in claim 17, characterised in that

at least two of said sections (34) include means for selectively receiving and sending telecommunications signals from and to said ground stations and/or others of said relay stations, so that, if said last named means on one of said sections fails, the other section will continue to operate and thereby keep the relay station in service.

19. A system as defined in claim 17, characterised in that

at least two of said sections (34) include means for providing energy for said means for receiving and sending telecommunications signals and/or said means for controlling the lateral and vertical movement of said relay stations, so that if said last named means on one of said sections fails, the other section will continue to operate and thereby keep the relay station in service.

20. A system as defined in claim 1, characterised in that

said means for receiving and sending telecommunications signals from and to said ground stations and from and to the other or others of said relay stations, if provided, operates at frequencies that are the same as those allocated to terrestrial telecommunications.

21. A system as defined in claim 1, characterised in that

there are a plurality of relay stations, and
relay stations stationed over more densely populated areas (132) are lower than relay stations stationed over less densely populated areas (134).

22. A system as defined in claim 1, characterised in that

there are a plurality of relay stations,
the relay stations over more densely populated areas (132) have a narrow focus (142) for the angle of reception and propagation of telecommunications signals, and
the relay stations over less densely populated areas (134) have a broad focus (144) for the angle of reception and propagation of telecommunications signals.

23. A telecommunications method comprising the steps of:

providing at least two ground stations (18, 120, 140) and at least one relay station (28, 130, 114),
positioning said at least one relay station at a predetermined altitude for receiving and transmitting telecommunications signals to and from said ground stations and the other or others of said relay stations,
transmitting a telecommunications signal from a first one of said ground stations to said at least one relay station,
receiving said telecommunications signal at said at least one relay station and transmitting said signal to a second ground station, and
maintaining said at least one relay station at said predetermined altitude for sending and receiving said telecommunications signals to and from said ground stations and the other or others of said relay stations,

characterised in that said predetermined altitude is between about 19 and 56 km (12 and 35 miles),

and in that lateral movement of said at least one relay station (28, 130, 114) is also controlled, said control of movement comprising:

(i) identifying a current altitude or location over the earth of said at least one relay station,
(ii) identifying a predetermined altitude or location for said at least one relay station, and
(iii)moving said at least one relay station from said current altitude or location to said predetermined altitude or location.

24. A method as defined in claim 23, including the steps of

identifying the current altitude and location over the earth of said at least one relay station,
identifying said predetermined altitude and location for said at least one relay station, and
moving said at least one relay station from said current altitude and location to said predetermined altitude and/or location.

25. A method as defined in claim 23 or 24 wherein the step of moving said at least one relay station includes the step of

applying a thrust force to said at least one relay station in the direction in which it is to move.

26. A method as defined in claim 25, including the step of

enabling said relay station or stations to receive and store energy, and
using said energy to create said thrust force and to enable said relay station or stations to transmit and receive telecommunications signals.

27. A method as defined in claim 26, wherein

said at least one relay station can receive and store solar energy.

28. A method as defined in claim 26, wherein

said at least one relay station can receive and store microwave energy.

29. A method as defined in claim 26, wherein

said at least one relay station can receive and store wind energy.

30. A method as defined in claim 26, wherein

said energy is chemical energy.

31. A method as defined in claim 23 or 24 including the step of

returning said at least one relay station to a predetermined location on the earth.

32. A method as defined in claim 23, wherein

at least one of said ground stations is mobile.

33. A method as defined in claim 23, wherein

said at least one relay station is lighter than air.

34. A method as defined in claim 33, wherein

said at least one relay station is inflated with a gas.

35. A method as defined in claim 33 including

the step of controlling the altitude of said at least one relay station.

36. A method as defined in claim 35, including the step of controlling the altitude of said relay station, wherein

said step of controlling the altitude of said relay station includes controlling the temperature of said gas.

37. A method as defined in claim 36, wherein

the temperature of said gas is controlled by controlling the amount of solar radiant energy that enters a balloon (32).

38. A method as defined in claim 37, wherein

said step of controlling the amount of solar energy that enters said balloon includes the step of changing the transparency of the skin of said balloon.

39. A method as defined in claim 38, wherein

at least a portion of said skin is comprised of electro-chromatic material.

40. A method as defined in claim 38, wherein

said balloon includes a skin, and
at least a portion of said skin is comprised of photo-chromatic material.

41. A method as defined in claim 23, wherein

the step of providing at least one relay station includes the step of providing it with a plurality of sections (34),
selectively receiving and sending telecommunications signals from and to said ground stations and/or the other or others of said relay stations by at least one of said sections,
transmitting energy to said last-named section from at least one of said other sections, and
wherein said energy is operative to enable said telecommunications.

42. A method as defined in claim 41, wherein

the step of receiving and sending telecommunications signals from and to said ground stations and/or the other or others of said relay stations is by at least two of said sections so that, if there is a failure of the ability to send and/or receive telecommunications signals from or to one of said sections, the other section will continue to operate and thereby keep the relay sta-

tion in service.

43. A method as defined in claim 41, wherein

said energy that is transmitted is microwave energy, and the method includes
converting said microwave energy to electric energy, and using said electric energy for said telecommunications.

44. A method as defined in claim 23, wherein

said telecommunications signals are at the same frequencies as those allocated to terrestrial telecommunications signals.

45. A method as defined in claim 23 including the step of

providing a plurality of relay stations,
and locating relay stations stationed over more densely populated areas (132) at lower altitudes than relay stations located over less densely populated areas (134).

46. A method as defined in claim 23 including the step of

providing a plurality of relay stations,
providing a narrow focus for the angle of reception and propagation of telecommunications signals for those relay stations over more densely populated areas (132), and
providing a broad focus for the angle of reception and propagation of telecommunications signals for those relay stations over less densely populated areas (134).

47. A method as defined in claim 23, wherein

the step of transmitting said telecommunications signal to said second ground station includes the steps of
providing a second relay station,
transmitting said telecommunications signal from said first relay station to said second relay station, and
transmitting said telecommunications signal from said second relay station to said second ground station.

48. A relay station (28, 130, 114) for a high altitude suborbital telecommunications system, the relay station comprising:

means for receiving and sending telecommunications signals from and to ground stations (18, 120, 140) and from and to other relay stations, and
means for controlling the vertical movement of said relay station so that a predetermined altitude can be achieved and maintained for sending and receiving said telecommunications signals to and from said ground stations and said other relay stations,

characterised in that said controlling means is adapted to maintain the altitude at between about 19 and 56 km (12 to 35 miles), and also controls lateral movement of the relay station,

said means for controlling the lateral and vertical movement of said relay station comprising

(i) first means for identifying the current altitude and/or location of said relay station, and
(ii) second means for identifying a predetermined altitude and/or location for said relay station, and
(iii)an energizable thrust system on said relay station, said thrust system being selectively operative to move said relay station from its current altitude and location to said predetermined altitude and/or location.

49. A relay station as defined in claim 48, characterised in that

said relay station comprises a balloon (32).

50. A relay station as defined in claim 49, characterised in that

said balloon includes means for controlling the temperature of the gas that it contains.

51. A relay station as defined in claim 50, characterised in that

said balloon includes a skin, and
at least a portion of said skin is comprised of electro-chromatic material.

52. A relay station as defined in claim 50, characterised in that

said balloon includes a skin, and
at least a portion of said skin is comprised of photchromatic material.

53. A relay station as defined in claim 49, characterised in that

said balloon includes means for controlling its altitude.

54. A relay station as defined in claim 48, characterised in that

said relay station comprises an inflatable device (32), and
means (152) are connected to said inflatable device for deflating it while it is aloft.

55. A relay station as defined in claim 54, characterised in that

said means for deflating said inflatable device is operative in response to a signal from a remote source.

56. A relay station as defined in claim 54, characterised in that

said inflatable device includes a parachute (154) for controlling its descent when it is recovered.

Patentansprüche

1. Telekommunikationssystem (10) mit:

zumindest zwei Bodenstationen (18, 120, 140), wobei jede der Bodenstationen Einrichtungen (20, 36, 118, 128) zum Aussenden und zum Empfang von Telekommunikationssignalen einschließt,
zumindest einer Relaisstation (28, 130, 114), wobei die Relaisstation Einrichtungen zum Empfang und zum Aussenden von Telekommunikationssignalen von und zu den Bodenstationen und von und zu anderen der Relaisstationen einschließt,
wobei sich die zumindest eine Relaisstation (28, 130, 114) in einer vorgegebenen Höhe befindet, um Telekommunikationssignale von und zu den Bodenstationen und von und zu anderen der Relaisstationen zu empfangen und auszusenden,
einer Einrichtung (90, 94, 108, 112) auf der zumindest einen Relaisstation zur Steuerung der vertikalen und lateralen Bewegung der Relaisstation oder -stationen derart, daß die vorgegebene Höhe erreicht und aufrechterhalten werden kann,

dadurch gekennzeichnet, daß die vorgegebene Höhe zwischen ungefähr 19 und 56 kn (12 und 35 Meilen) liegt und daß die Steuereinrichtung (90, 94, 108, 112) außerdem die laterale Bewegung der zumindest einen Bodenstation steuert,

wobei die Einrichtung zur Steuerung der vertikalen und lateralen Bewegung der zumindest einen Relaisstationen derart, daß eine vorgegebene Höhe und Position der zumindest einen Relaisstation erreicht und aufrecht erhalten wird, folgendes umfaßt:

(i) erste Einrichtungen, die zur selektiven oder gleichzeitigen Identifikation der derzeitigen Höhe oder Position der zumindest einen Relaisstation betreibbar sind,
(ii) zweite Einrichtungen, die zur selektiven oder gleichzeitigen Identifikation der vorgegebenen Höhe oder Position für die zumindest eine Relaisstation betreibbar sind, und (iii) Einrichtungen zum Bewegen der zumindest einen Relaisstation von der derzeitigen Höhe oder Position auf die vorgegebene Höhe oder Position.

2. System nach Anspruch 2, dadurch gekennzeichnet, daß die Einrichtung zum Steuern der zumindest einen Relaisstation auf der vorgegebenen Höhe oder Position ein Vortriebssystem (90, 108, 112) umfaßt, und daß Einrichtungen zur selektiven Ansteuerung und Energieversorgung des Vortriebssystems vorgesehen sind.

3. System nach Anspruch 1, dadurch gekennzeichnet, daß die Einrichtung zur Steuerung der vertikalen und lateralen Bewegung der Relaisstation oder der Relaisstationen derart, daß die vorgegebene Höhe und Position der Relaisstation oder der Relaisstationen erreicht und aufrecht erhalten wird, folgendes umfaßt:

(i) erste Einrichtungen, die zur selektiven oder gleichzeitigen Identifikation der derzeitigen Höhe oder Position der zumindest einen Relaisstation betreibbar sind,
(ii) zweite Einrichtungen, die zur selektiven oder gleichzeitigen Identifikation einer vorgegebenen Höhe oder Position der zumindest einen Relaisstation betreibbar sind, und
(iii) Einrichtungen zum Bewegen der zumindest einen Relaisstation von der derzeitigen Höhe oder Position auf die vorgegebene Höhe oder Position.

4. System nach Anspruch 3, dadurch gekennzeichnet, daß die Einrichtung zum Steuern der zumindest einen Relaisstation auf der vorgegebenen Höhe oder Position ein Vortriebssystem (90, 108, 112) umfaßt, und daß Einrichtungen zur selektiven Ansteuerung und Energieversorgung des Vortriebssystems vorgesehen sind.

5. System nach Anspruch 1, das ein bodengestütztes Telekommunikationsnetz (16) einschließt, wobei

zumindest eine der Bodenstationen mit dem Telekommunikationsnetz verbunden ist.

6. System nach Anspruch 1, bei dem zumindest eine der Bodenstationen eine mobile Station (22, 24, 122) ist.

7. System nach Anspruch 1, 2 oder 3, dadurch gekennzeichnet, daß die zumindest eine Relaisstation leichter als Luft ist.

8. System nach Anspruch 7, dadurch gekennzeichnet, daß die Einrichtung zur Steuerung der lateralen Position ein Vortriebssystem umfaßt, und daß elektrische Einrichtungen zum Antrieb der Vortriebssystems vorgesehen sind.

9. System nach Anspruch 7, dadurch gekennzeichnet, daß die zumindest eine Relaisstation eine aufblasbare Vorrichtung (32) umfaßt und daß Einrichtungen (152) mit der aufblasbaren Vorrichtung verbunden sind, um aus dieser Gase abzulassen, während sie sich in der Luft befindet.

10. System nach Anspruch 9, dadurch gekennzeichnet, daß die Einrichtung zum Ablassen von Gas aus der aufblasbaren Vorrichtung in Abhängigkeit von einem Signal von einer entfernten Quelle betreibbar ist.

11. System nach Anspruch 9, dadurch gekennzeichnet, daß die aufblasbare Vorrichtung einen Fallschirm (154) mit Steuerleinen (198) zur Steuerung des Abstiegs der aufblasbaren Vorrichtung einschließt, wenn diese geborgen wird.

12. System nach Anspruch 1, dadurch gekennzeichnet, daß die zumindest eine Relaisstation einen Ballon (32) umfaßt.

13. System nach Anspruch 12, dadurch gekennzeichnet, daß der Ballon Einrichtungen zur Steuerung seiner Höhe einschließt.

14. System nach Anspruch 12, daurch gekennzeichnet, daß der Ballon Einrichtungen zur Steuerung der Temperatur des in ihm enthaltenen Gases einschließt.

15. System nach Anspruch 12, dadurch gekennzeichnet, daß der Ballon eine Hülle einschließt, wobei zumindestens ein Teil der Hülle aus elektrochromatischem Material gebildet ist.

16. System nach Anspruch 12, dadurch gekennzeichnet, daß der Ballon eine Hülle einschließt, wobei zumindest ein Teil der Hülle aus photochromatischem Material gebildet ist.

17. System nach Anspruch 1 mit zumindest drei Relaisstationen, dadurch gekennzeichnet, daß

einige der Relaisstationen eine Vielzahl von Abschnitten (34) umfassen,
zumindest einer der Abschnitte Einrichtungen zum selektiven Empfang und zum Aussenden von Telekommunikationssignalen von und zu den Bodenstationen und/oder von und zu anderen der Relaisstationen einschließt, und
zumindest einer der Abschnitte Einrichtungen zur Lieferung von Energie für die Einrichtungen zum Empfangen und zum Aussenden von Telekommunikationssignalen und/oder für die Einrichtungen zur Steuerung der lateralen und vertikalen Bewegung der Relaisstationen einschließt.

18. System nach Anspruch 17, dadurch gekennzeichnet, daß zumindest zwei der Abschnitte (34) Einrichtungen zum selektiven Empfang und zum Aussenden von Telekommunikationssignalen von und zu den Bodenstationen und/oder anderen der Relaisstationen einschließen, so daß, wenn die letztgenannte Einrichtung an einem der Abschnitte ausfällt, der andere Abschnitt weiterarbeitet und die Relaisstation in Betrieb hält.

19. System nach Anspruch 17, dadurch gekennzeichnet, daß zumindest zwei der Abschnitte (34) Einrichtungen zur Lieferung von Energie an die Einrichtungen zum Empfangen und Aussenden von Telekommunikationssignalen und/oder der Einrichtungen zur Steuerung der lateralen und vertikalen Bewegung der Relaisstationen einschließen, so daß, wenn die letztgenannte Einrichtungen an einem der Abschnitte ausfällt, der andere Abschnitt weiterarbeitet und damit die Relaisstation in Betrieb hält.

20. System nach Anspruch 1, dadurch gekennzeichnet, daß die Einrichtung zum Empfangen und Senden von Telekommunikationssignalen von und zu den Bodenstationen und von und zu anderen der Relaisstationen, falls vorgesehen, mit Frequenzen arbeitet, die die gleichen sind wie die, die für eine terrestrische Telekommunikation zugeteilt sind.

21. System nach Anspruch 1, dadurch gekennzeichnet, daß

eine Vielzahl von Relaisstationen vorgesehen ist, und
Relaisstationen, die über dichter besiedelten Bereichen (132) stationiert sind, niedriger angeordnet sind als Relaisstationen, die über weniger dicht besiedelten Bereichen (134) stationiert sind.

22. System nach Anspruch 1, dadurch gekennzeichnet, daß

eine Vielzahl von Relaisstationen vorgesehen ist,
die Relaisstationen über dichter besiedelten Bereichen (132) einen schmalen Fokus (142) für den Winkel für den Empfang und die Aussendung von Telekommunikationssignalen aufweisen, und
die Relaisstationen über weniger dicht besiedelten Bereichen (134) einen breiten Fokus (144) für den Winkel des Empfangs und der Aussendung von Telekommunikationssignalen aufweisen.

23. Telekommunikationsverfahren mit den folgenden Schritten:

Schaffung von zumindest zwei Bodenstationen (18, 120, 140) und zumindest einer Relaisstation (28, 130, 114),
Positionierung der zumindest einen Relaisstation an einer festen vorgegebenen Position über der Erde zum Empfang und zur Aussendung von Telekommunikationssignalen zu und von den Bodenstationen und der oder den anderen Relaisstationen,
Aussenden eines Kommunikationssignals von einer ersten der Bodenstationen zu der zumindest einen Relaisstation,
Empfangen des Kommunikationssignals an der zumindest einen Relaisstation und Aussenden des Signals an eine zweite Bodenstation, und
Halten der zumindest einen Relaisstation an der festen vorgegebenen Höhe und Position zum Aussenden und zum Empfang von Telekommunikationssignalen zu und von den Bodenstationen und der oder den anderen Relaisstationen,

dadurch gekennzeichnet, daß die vorgegebene Höhe zwischen ungefähr 19 und 56 km (12 und 35 Meilen) liegt,

und daß die laterale Bewegung der zumindest einen Relaisstation (28, 130, 114) ebenfalls gesteuert wird,
daß die Steuerung der Bewegung die folgenden Schritte einschließt:

(i) Identifizieren einer derzeitigen Höhe oder Position der zumindest einen Relaisstation über der Erde,
(ii) Identifikation einer vorgegebenen Höhe oder Position für die zumindest eine Relaisstation, und
(iii) Bewegen der zumindest einen Relaisstation von ihrer derzeitigen Höhe oder Position auf die vorgegebene Höhe oder Position.

24. Verfahren nach Anspruch 23, das die folgenden Schritte einschließt:

Identifizieren einer derzeitigen Höhe oder Position der zumindest einen Relaisstation über der Erde,
Identifikation einer vorgegebenen Höhe oder Position für die zumindest eine Relaisstation, und
Bewegen der zumindest einen Relaisstation von ihrer derzeitigen Höhe oder Position auf die vorgegebene Höhe und/oder Position.

25. Verfahren nach Anspruch 23 oder 24, bei dem der Schritt des Bewegens der zumindest einen Relaisstation den Schritt des Ausübens einer Vortriebskraft auf die zumindest eine Relaisstation in der Richtung einschließt, in der sie sich bewegen soll.

26. Verfahren nach Anspruch 25, das den Schritt des Ermöglichens des Empfangs und der Speicherung der Energie durch die Relaisstation oder die Relaisstationen und der Verwendung der Energie zur Erzeugung der Vortriebskraft und zur Ermöglichung der Aussendung und des Empfangs von Telekommunikationssignalen durch die Relaisstation oder die Relaisstationen einschließt.

27. Verfahren nach Anspruch 26, bei dem die zumindest eine Relaisstation Solarenergie empfangen und speichern kann.

28. Verfahren nach Anspruch 26, bei dem die zumindest eine Relaisstation Mikrowellenenergie empfangen und speichern kann.

29. Verfahren nach Anspruch 26, bei dem die zumindest eine Relaisstation Windenergie empfangen und speichern kann.

30. Verfahren nach Anspruch 26, bei dem die Energie chemische Energie ist.

31. Verfahren nach Anspruch 26, das den Schritt der Rückführung der zumindest einen Relaisstation zu einer vorgegebenen Position auf der Erde einschließt.

32. Verfahren nach Anspruch 23, bei dem zumindestens eine der Bodenstationen eine mobile Station ist.

33. Verfahren nach Anspruch 23, bei dem die zumin-

dest eine Relaisstation leichter als Luft ist.

34. Verfahren nach Anspruch 33, bei dem die zumindest eine Relaisstation mit einem Gas aufgeblasen ist.

35. Verfahren nach Anspruch 33, das den Schritt der Steuerung der Höhe der zumindest einen Relaisstation einschließt.

36. Verfahren nach Anspruch 35, das den Schritt der Steuerung der Höhe der Relaisstation einschließt, wobei

der Schritt der Steuerung der Höhe der Relaisstation die Steuerung der Temperatur des Gases einschließt.

37. Verfahren nach Anspruch 36, bei dem die Temperatur des Gases durch Steuern der Menge an Solarstrahlungsenergie gesteuert wird, die in den Ballon (32) eintritt.

38. Verfahren nach Anspruch 37, bei dem der Schritt der Steuerung der Menge an Solarenergie, die in den Ballon eintritt, den Schritt der Änderung der Lichtdurchlässigkeit der Hülle des Ballons einschließt.

39. Verfahren nach Anspruch 38, bei dem zumindestens ein Teil der Hülle aus elektrochromatischem Material besteht.

40. Verfahren nach Anspruch 38, bei dem der Ballon eine Hülle einschließt, und bei dem zumindest ein Teil der Hülle aus photochromatischem Material besteht.

41. Verfahren nach Anspruch 23, bei dem der Schritt der Schaffung einer Relaisstation den Schritt der Schaffung der Relaisstation mit einer Vielzahl von Abschnitten (34), das selektive Empfangen und Aussenden von Telekommunikationssignalen von und zu den Bodenstationen und/oder von und zu der oder den anderen Relaisstation(en) durch zumindest einen der Abschnitte und die Übertragung von Energie an den zuletzt genannten Abschnitt von zumindest einem der anderen Abschnitte aus einschließt, wobei die Energie zur Ermöglichung der Telekommunikation verwendbar ist.

42. Verfahren nach Anspruch 41, bei dem der Schritt des Empfangens und Sendens von Telekommunikationssignalen von und zu den Bodenstationen und/oder von und zu der oder den anderen Relaisstation(en) durch zumindestens zwei der Abschnitte erfolgt, so daß, wenn ein Ausfall der Fähigkeit zum Senden und/oder zum Empfang von Telekommunikationssignalen von oder zu einem der Abschnitte auftritt, der andere Abschnitt weiterarbeitet und damit die Relaisstation in Betrieb hält.

43. Verfahren nach Anspruch 41, bei dem die Energie, die übertragen wird, Mikrowellenenergie ist, wobei das Verfahren die Umwandlung der Mikrowellenenergie in elektrische Energie und die Verwendung der elektrische Energie für die Telekommunikation einschließt.

44. Verfahren nach Anspruch 23, bei dem die Telekommunikationssignale die gleichen Frequenzen aufweisen wie die, die terrestrischen Kommunikationssignalen zugeteilt sind.

45. Verfahren nach Anspruch 23, das den Schritt der Schaffung einer Vielzahl von Relaisstationen, der Positionierung der über dichter besiedelten Bereichen (132) stationierten Relaisstationen in niedrigeren Höhen als Relaisstationen einschließt, die über weniger dicht besiedelten Bereichen (134) positioniert sind.

46. Verfahren nach Anspruch 23, das den Schritt der Schaffung einer Vielzahl von Relaisstationen, die Schaffung eines schmalen Fokus für den Winkel des Empfangs und der Ausbreitung von Telekommunikationssignalen für die Relaisstationen über dichter besiedelten Bereichen (132) und die Schaffung eines breiten Fokus für den Winkel des Empfangs und der Ausbreitung von Telekommunikationssignalen für die Relaisstationen über weniger dicht besiedelten Bereichen (134) einschließt.

47. Verfahren nach Anspruch 23, bei dem der Schritt der Übertragung des Telekommunikationssignals an die zweite Bodenstation die Schritte der Schaffung einer zweiten Relaisstation, der Übertragung des Telekommunikationssignals von der ersten Relaisstation zur zweiten Relaisstation und der Übertragung des Telekommunikationssignals von der zweiten Relaisstation zu der zweiten Bodenstation einschließt.

48. Relaisstation (28, 130, 114) für ein suborbitales Kommunikationssystem mit großer Höhe, wobei die Relaisstation folgendes umfaßt:

Einrichtungen zum Empfang und zur Aussendung von Telekommunikationssignalen von und zu Bodenstationen (18, 120, 140) und von und zu anderen Relaisstationen, und
Einrichtungen zur Steuerung der Vertikalbewegung der Relaisstationen derart, daß eine vorgegebene Höhe erzielt und aufrechterhalten werden kann, um die Telekommunikationssignale zu und von den Bodenstationen und den

anderen Relaistationen auszusenden und zu empfangen,

dadurch gekennzeichnet, daß die Steuereinrichtung zur Aufrechterhaltung der Höhe auf zwischen 19 und 56 km (12 bis 35 Meilen) ausgebildet ist und weiterhin die laterale Bewegung der Relaisstation steuert,

die Einrichtung zur Steuerung der lateralen und vertikalen Bewegung der Relaisstation folgendes umfaßt.

(i) erste Einrichtungen zur Identifikation der derzeitigen Höhe und/oder Position der Relaisstation, und
(ii) zweite Einrichtungen zur Identifikation einer vorgegebenen Höhe und/oder Position für die Relaisstation und
(iii) ein ansteuerbares Vortriebssystem an der Relaisstation, wobei das Vortriebssystem selektiv betreibbar ist, um die Relaisstation von ihrer derzeitigen Höhe und Position auf die vorgegebene Höhe und/oder Position zu bewegen.

49. Relaisstation nach Anspruch 48, dadurch gekennzeichnet, daß die Relaisstation einen Ballon (32) umfaßt.

50. Relaisstation nach Anspruch 49, dadurch gekennzeichnet, daß der Ballon Einrichtungen zur Steuerung der Temperatur des Gases einschließt, das er enthält.

51. Relaisstation nach Anspruch 50, dadurch gekennzeichnet, daß der Ballon eine Hülle einschließt, und daß zumindest ein Teil der Hülle aus elektrochromatischem Material besteht.

52. Relaisstation nach Anspruch 50, dadurch gekennzeichnet, daß der Ballon eine Hülle einschlueßt, und daß zumindest ein Teil der Hülle aus photochromatischem Material besteht.

53. Relaisstation nach Anspruch 43, dadurch gekennzeichnet, daß der Ballon Einrichtungen zur Steuerung seiner Höhe einschließt.

54. Relaisstation nach Anspruch 48, dadurch gekennzeichnet, daß die Relaisstation eine aufblasbare Vorrichtung (32) aufweist, und daß eine Einrichtung (152) mit der aufblasbaren Vorrichtung verbunden sind, um Gas aus dieser auszulassen, während sie sich in der Höhe befindet.

55. Relaisstion nach Anspruch 44, dadurch gekennzeichnet, daß die Einrichtung zum Ablassen von Gas aus der aufblasbaren Vorrichtung in Abhängigkeit von einem Signal von einer entfernten Quelle betreibbar ist.

56. Relaisstation nach Anspruch 54, dadurch gekennzeichnet, daß die aufblasbare Vorrichtung einen Fallschirm (154) zur Steuerung ihres Absinkens beim Rückholen einschließt.

Revendications

1. Système de télécommunication (10) comprenant :

au moins deux stations au sol (18, 120, 140), chacune desdites stations au sol comprenant des moyens (20, 36, 118, 128) pour envoyer et recevoir des signaux de télécommunication,
au moins une station relais (28, 130, 114), ladite station relais ou chacune d'entre elles comprenant des moyens pour recevoir et envoyer des signaux de télécommunication en provenance et à destination desdites stations au sol et en provenance et à destination de l'autre ou des autres station(s) relais,
ladite au moins une station relais (28, 130, 114) se trouvant à une altitude prédéterminée pour émettre et recevoir les signaux de télécommunication en provenance et à destination desdites stations au sol et en provenance et à destination de l'autre ou des autres station(s) relais,
et des moyens (90, 94, 108, 112) sur ladite au moins une station relais pour commander le mouvement vertical de ladite ou desdites station(s) relais afin que ladite altitude prédéterminée soit atteinte et maintenue, caractérisé en ce que ladite altitude prédéterminée a une valeur comprise entre environ 19 et 56 km (12 et 35 miles), lesdits moyens de commande (90, 94, 108, 112) commandant également le mouvement latéral de ladite au moins une station relais, et
lesdits moyens pour commander le mouvement vertical et latéral de ladite au moins une station relais de telle sorte que ladite altitude prédéterminée et une position prédéterminée de ladite au moins une station relais soient atteintes et maintenues comportent

(i) des premiers moyens fonctionnant pour identifier sélectivement ou simultanément l'altitude ou la position courante de ladite au moins une station relais,
(ii) des seconds moyens fonctionnant pour identifier sélectivement ou simultanément ladite altitude ou position prédéterminée pour ladite au moins une station relais,

et (iii) des moyens pour déplacer ladite au moins une station relais à partir de ladite altitude ou position courante vers ladite altitude ou position prédéterminée.

2. Système selon la revendication 1, caractérisé en ce que lesdits moyens pour commander ladite au moins une station relais à ladite altitude ou position prédéterminée comportent un système de poussée (90, 108, 112), et

des moyens sont prévus pour activer sélectivement ledit système de poussée.

3. Système selon la revendication 1, caractérisé en ce que lesdits moyens pour commander le mouvement vertical et latéral de ladite ou desdites station(s) relais afin que ladite altitude et position prédéterminées de ladite ou desdites station(s) relais soit atteintes et maintenues comportent

des premiers moyens fonctionnant pour identifier sélectivement ou simultanément l'altitude et la position courante de ladite au moins une station relais,
des seconds moyens fonctionnant pour identifier sélectivement ou simultanément une altitude et une position prédéterminées de ladite au moins une station relais,
et des moyens pour déplacer ladite au moins une station relais à partir desdites altitude et position courantes vers lesdites altitude et/ou position prédéterminées.

4. Système selon la revendication 3, caractérisé en ce que

lesdits moyens pour commander ladite au moins une station relais auxdites altitude et position prédéterminées comportent un système de poussée (90, 108, 112), et
des moyens sont prévus pour activer sélectivement ledit système de poussée.

5. Système selon la revendication 1, comprenant

un réseau de télécommunication basé au sol (16), et dans laquelle au moins une desdites stations au sol est reliée audit système de télécommunication.

6. Système selon la revendication 1, caractérisé en ce que

au moins une desdites stations au sol est mobile (22, 24, 122).

7. Système selon la revendication 1, 2 ou 3, caractérisé en ce que

ladite au moins une station relais est plus légère que l'air.

8. Système selon la revendication 7, caractérisé en ce que

lesdits moyens pour commander ledit mouvement latéral comportent un système de poussée, et
des moyens électriques sont prévus pour entraîner ledit système de poussée.

9. Système selon la revendication 7, caractérisé en ce que ladite au moins une station relais comporte un dispositif gonflable (32), et

des moyens (152) sont connectés audit dispositif gonflable pour le dégonfler pendant qu'il est en l'air.

10. Système selon la revendication 9, caractérisé en ce que

lesdits moyens pour dégonfler ledit dispositif gonflable peuvent fonctionner en réponse à un signal provenant d'une source à distance.

11. Système selon la revendication 9, caractérisé en ce que

ledit dispositif gonflable comporte un parachute (51) ayant des suspentes pour commander sa descente lors de la récupération.

12. Système selon la revendication 1, caractérisé en ce que

ladite au moins une station relais comprend un ballon (32).

13. Système selon la revendication 12, caractérisé en ce que

ledit ballon comporte des moyens pour commander son altitude.

14. Système selon la revendication 12, caractérisé en ce que

ledit ballon comporte des moyens pour commander la température du gaz qu'il contient.

15. Système selon la revendication 12, caractérisé en ce que

ledit ballon comprend une peau, et

au moins une partie de ladite peau est constituée d'un matériau électrochromatique

16. Système selon la revendication 12, caractérisé en ce que

ledit ballon comprend une peau, et
au moins une partie de ladite peau est constituée d'un matériau photochromatique.

17. Système selon la revendication 1 avec au moins trois stations relais, caractérisé en ce que

certaines desdites stations relais comprennent une pluralité de sections (34),
au moins une desditcs sections comprenant des moyens pour recevoir et envoyer sélectivement des signaux de télécommunication en provenance et à destination desdites stations au sol et/ou d'autres desdites stations relais, et
au moins une desdites sections comprenant des moyens pour fournir de l'énergie auxdits moyens pour recevoir et envoyer des signaux de télécommunication et/ou auxdits moyens pour commander le mouvement latéral et vertical desdites stations relais.

18. Système selon la revendication 17, caractérisé en ce que

au moins une desdites sections (34) comprend des moyens pour recevoir et envoyer sélectivement des signaux de télécommunication en provenance et à destination desdites stations au sol et/ou d'autres desdites stations relais, de telle sorte que, si ces derniers moyens sont en panne sur l'une desdites sections, l'autre section puisse continuer de fonctionner et maintenir ainsi la station relais en service.

19. Système selon la revendication 17, caractérisé en ce que

au moins deux desdites sections (34) comprennent des moyens pour fournir de l'énergie auxdits moyens pour recevoir et envoyer des signaux de télécommunication et/ou auxdits moyens pour commander le mouvement latéral vertical desdites stations relais, de sorte que si ces derniers moyens tombent en panne sur l'une desdites section, l'autre section puisse continuer de fonctionner et maintenir ainsi la station relais en service.

20. Système selon la revendication 1, caractérisé en ce que

lesdits moyens pour recevoir et envoyer des signaux de télécommunication en provenance et à destination desdites stations au sol et en provenance et à destination de l'autre ou des autres desdites stations relais, s'ils sont prévus, fonctionnent à des fréquences qui sont les mêmes que celles allouées aux télécommunications terrestres.

21. Système selon la revendication 1, caractérisé en ce que

il existe une pluralité de stations relais, et
les station relais stationnant au-dessus de zones ayant une plus forte densité de population (132) sont plus basses que celles stationnées au-dessus de zones à densité de population plus faible (134).

22. Système selon la revendication 1, caractérisé en ce que

il existe une pluralité de stations relais,
les stations relais situées au-dessus de zones à plus forte densité de population (132) ont une focalisation étroite (142) pour l'angle de réception et de propagation des signaux de télécommunication, et
les stations relais situées au-dessus de zones de plus faible densité de population (134) ont une focalisation large (144) pour l'angle de réception et de propagation des signaux de télécommunication.

23. Procédé de télécommunication comportant les étapes consistant à :

prévoir au moins deux stations au sol (18, 120, 140) et au moins une station relais (28, 130, 114),
positionner ladite au moins une station relais à une altitude prédéterminée pour recevoir et transmettre des signaux de télécommunication à destination et en provenance desdites stations au sol et de l'autre ou des autres station (s) relais,
transmettre un signal de télécommunication depuis une première desdites stations au sol vers ladite au moins une station relais,
recevoir ledit signal de télécommunication à ladite au moins une station relais et transmettre ledit signal à une seconde station au sol, et
maintenir ladite au moins une station relais à ladite altitude prédéterminée pour envoyer et recevoir lesdits signaux de télécommunication à destination et en provenance desdites stations au sol et de l'autre ou des autres station (s) relais,

caractérisé en ce que ladite altitude prédéterminée est comprise entre environ 19 et 56 km (12 et 35 miles),

et en ce que le mouvement latéral de ladite au moins une station relais (28, 130, 114) est également commandé,
ladite commande du mouvement comprenant :

(i) l'identification de l'altitude ou de la position courante au-dessus de la terre de ladite au moins une station relais,
(ii) l'identification d'une altitude ou position prédéterminée pour ladite au moins une station relais, et
(iii) le déplacement de ladite au moins une station relais à partir de ladite altitude ou position courante vers ladite altitude ou position prédéterminée.

24. Procédé selon la revendication 23, comprenant les étapes consistant à

identifier l'altitude et la position courante au-dessus de la terre de ladite au moins une station relais,
identifier ladite altitude et position prédéterminée pour ladite au moins une station relais, et
déplacer ladite au moins une station relais à partir desdites altitude et position courantes vers lesdites altitude et/ou position prédéterminées.

25. Procédé selon la revendication 23 ou 24, dans lequel l'étape de déplacement de ladite au moins une station relais comprend l'étape consistant à

appliquer une force de poussée à ladite au moins une station relais dans la direction dans laquelle celle-ci doit se déplacer.

26. Procédé selon la revendication 25, comprenant les étapes consistant à

permettre à ladite ou auxdites station(s) relais de recevoir et d'emmagasiner de l'énergie, et
utiliser cette énergie pour créer ladite force de poussée et pour permettre à ladite ou auxdites station(s) relais de transmettre et de recevoir des signaux de télécommunication.

27. Procédé selon la revendication 26, dans lequel

ladite au moins une station relais peut recevoir et emmagasiner de l'énergie solaire.

28. Procédé selon la revendication 26, dans lequel

ladite au moins une station relais peut recevoir et emmagasiner de l'énergie à micro-ondes.

29. Procédé selon la revendication 26, dans lequel

ladite au moins une station relais peut recevoir et emmagasiner de l'énergie éolienne.

30. Procédé selon la revendication 26, dans lequel

ladite énergie est de l'énergie chimique.

31. Procédé selon la revendication 23 ou 24, comprenant l'étape consistant à

faire retourner ladite au moins une station relais à une position prédéterminée sur terre.

32. Procédé selon la revendication 23, dans lequel

au moins une desdites stations au sol est mobile.

33. Procédé selon la revendication 23, dans lequel

ladite au moins une station relais est plus légère que l'air.

34. Procédé selon la revendication 33, dans lequel

ladite au moins une station relais est gonflée avec un gaz.

35. Procédé selon la revendication 33, comprenant l'étape consistant à commander l'altitude de ladite au moins une station relais.

36. Procédé selon la revendication 35, comprenant l'étape de commande de l'altitude de ladite station relais, dans lequel

ladite étape de commande de l'altitude de ladite station relais comprend la commande de la température dudit gaz.

37. Procédé selon la revendication 36, dans lequel

la température dudit gaz est commandée en commandant la quantité d'énergie solaire rayonnante qui entre dans le ballon (32).

38. Procédé selon la revendication 37, dans lequel

ladite étape de commande de la quantité d'énergie solaire qui entre dans ledit ballon comprend l'étape de changement de transparence de la peau dudit ballon.

39. Procédé selon la revendication 38, dans lequel

au moins une partie de ladite peau est constituée d'un matériau électrochromatique.

40. Procédé selon la revendication 38, dans lequel

ledit ballon comporte une peau, et
au moins une partie de ladite peau est constituée d'un matériau photochromatique.

41. Procédé selon la revendication 23. dans lequel

l'étape consistant à prévoir au moins une station relais comprend l'étape consistant à la prévoir avec une pluralité de sections (34),
recevoir et envoyer sélectivement des signaux de télécommunication en provenance et à destination desdites stations au sol et/ou de l'autre ou des autres station(s) relais par au moins une desdites sections,
transmettre de l'énergie à cette dernière section à partir d'au moins une desdites autres sections,
ladite énergie étant active pour permettre lesdites télécommunications.

42. Procédé selon la revendication 41, dans lequel

l'étape consistant à recevoir et envoyer des signaux de télécommunication en provenance et à destination desdites stations au sol et/ou de l'autre ou des autres station(s) relais est effectuée par au moins deux desdites sections, de sorte que, s'il se produit une panne de la capacité à envoyer et/ou à recevoir des signaux de télécommunication en provenance ou à destination d'une desdites sections, l'autre section puisse continuer à fonctionner et maintenir ainsi la station relais en service.

43. Procédé selon la revendication 41, dans lequel

ladite énergie qui est transmise est de l'énergie à micro-ondes, et le procédé comprend l'étape consistant à
convertir ladite énergie à micro-ondes en énergie électrique, et utiliser ladite énergie électrique pour lesdites télécommunications.

44. Procédé selon la revendication 23, dans lequel

lesdits signaux de télécommunication sont aux mêmes fréquences que celles allouées aux signaux de télécommunications terrestres.

45. Procédé selon la revendication 23, comprenant les étapes consistant à

prévoir une pluralité de stations relais,
et localiser les stations relais stationnées au-dessus de zones ayant une plus forte densité de population (132) à des altitudes plus basses que les stations relais situées au-dessus de zones à densité de population plus faible (134).

46. Procédé selon la revendication 23, comprenant les étapes consistant à

prévoir une pluralité de stations relais,
prévoir une focalisation étroite pour l'angle de réception et de propagation des signaux de télécommunication pour les stations relais au-dessus de zones à forte densité de population (132), et
prévoir une focalisation large pour l'angle de réception et de propagation des signaux de télécommunication pour les stations relais au-dessus de zones de population moins dense (134).

47. Procédé selon la revendication 23, dans lequel

l'étape de transmission dudit signal de télécommunication à ladite seconde station au sol comprend les étapes consistant à
prévoir une seconde station relais,
transmettre ledit signal de télécommunication à partir de ladite première station relais vers ladite seconde station relais, et
transmettre ledit signal de télécommunication à partir de ladite seconde station relais vers ladite seconde station au sol.

48. Station relais (28, 130, 114) pour un système de télécommunication suborbital à haute altitude, la station relais comportant

des moyens pour recevoir et envoyer des signaux de télécommunication en provenance et à destination de stations au sol (18, 120, 140) et en provenance et à destination d'autres stations relais, et
des moyens pour commander le mouvement vertical de ladite station relais de sorte qu'une altitude prédéterminée puisse être atteinte et maintenue pour envoyer et recevoir lesdits signaux de télécommunication à destination et en provenance desdites stations au sol et desdites autres stations relais,

caractérisée en ce que lesdits moyens de commande sont adaptés pour maintenir l'altitude entre environ 19 et 56 km (12 à 35 miles), et commande également le mouvement latéral de la station relais,

lesdits moyens pour commander le mouve-

ment latéral et vertical de ladite station relais comprenant

(i) des premiers moyens pour identifier l'altitude et/ou la position courante de ladite station relais, et
(ii) des seconds moyens pour identifier une altitude et/ou une position prédéterminée pour ladite station relais, et
(iii) un système de poussée activable sur ladite station relais, ledit système de poussée étant sélectivement opérationnel pour déplacer ladite station relais à partir de son altitude et de sa position courantes vers lesdites altitude et/ou position prédéterminées.

49. Station relais selon la revendication 48, caractérisée en ce que

ladite station relais comprend un ballon (32).

50. Station relais selon la revendication 49, caractérisée en ce que

ledit ballon comprend des moyens pour commander la température du gaz qu'il contient.

51. Station relais selon la revendication 50, caractérisée en ce que

ledit ballon comprend une peau, et
au moins une partie de ladite peau est constituée d'un matériau électrochromatique.

52. Station relais selon la revendication 50, caractérisée en ce que

ledit ballon comprend une peau, et
au moins une partie de ladite peau est constituée d'un matériau photochromatique.

53. Station relais selon la revendication 49, caractérisée en ce que

ledit ballon comprend des moyens pour commander son altitude.

54. Station relais selon la revendication 48, caractérisée en ce que

ladite station relais comprend un dispositif gonflable (32), et
des moyens (152) sont connectés audit dispositif gonflable pour le dégonfler pendant qu'il se trouve en l'air.

55. Station relais selon la revendication 54, caractérisée en ce que

lesdits moyens pour dégonfler ledit dispositif gonflable peuvent fonctionner en réponse à un signal provenant d'une source à distance.

56. Station relais selon la revendication 54, caractérisée en ce que

ledit dispositif gonflable comprend un parachute (154) pour commander sa descente lors de la récupération.

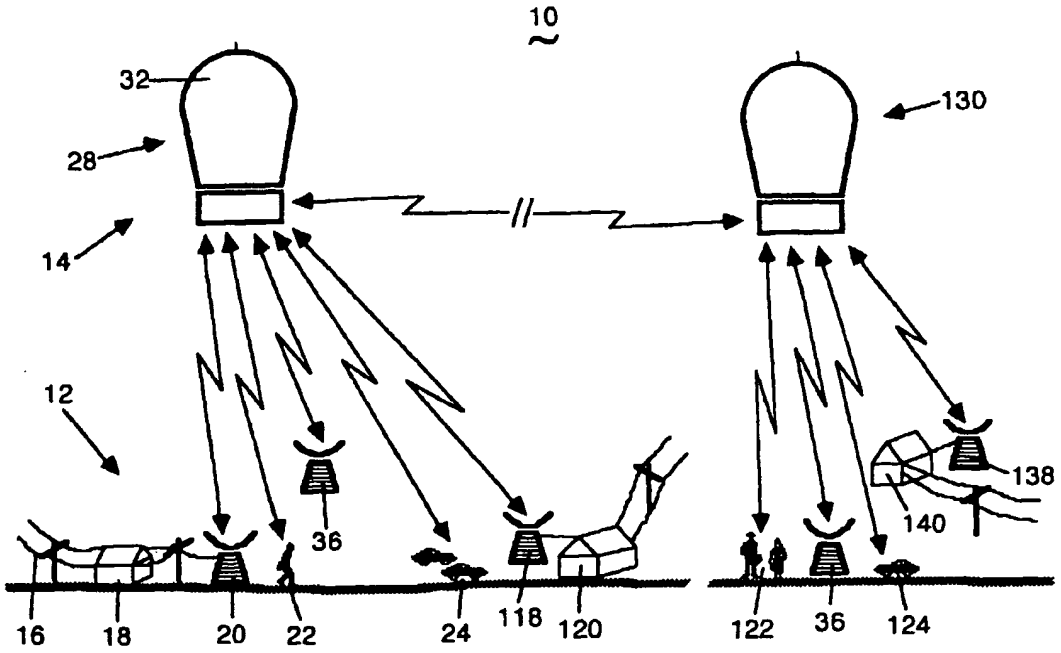
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FIG. 1

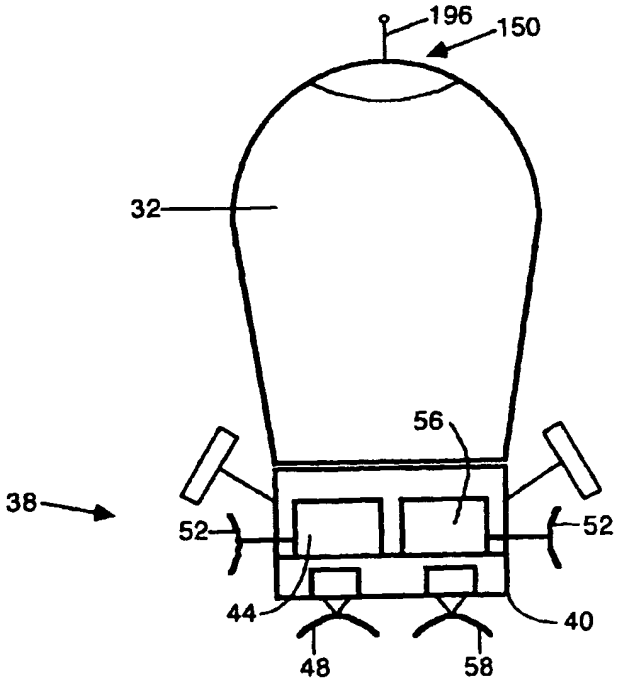
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FIG. 2

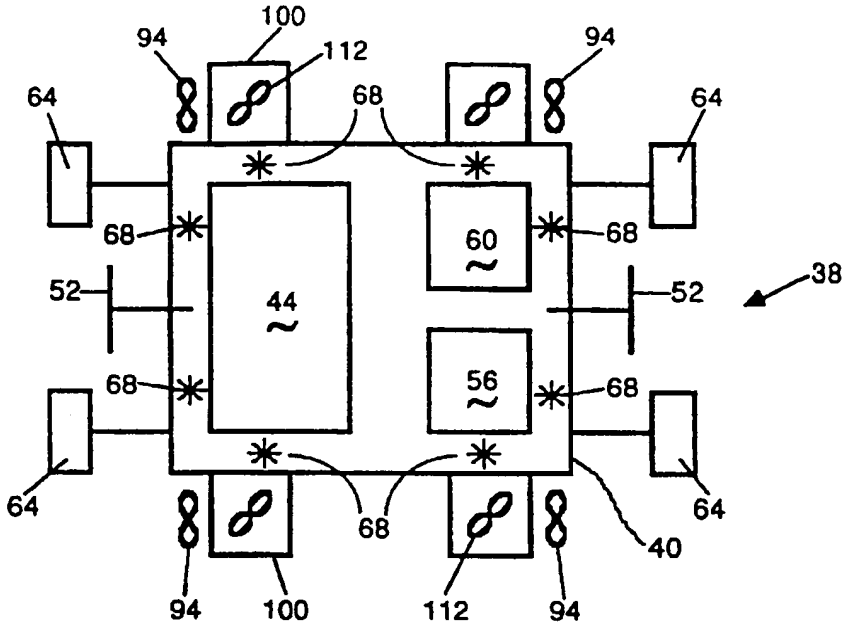
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FIG. 3

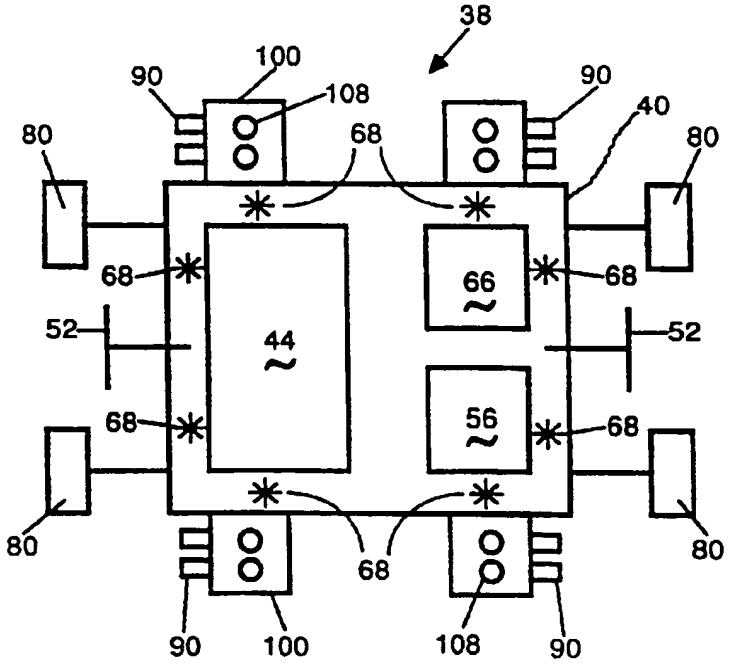
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FIG. 4

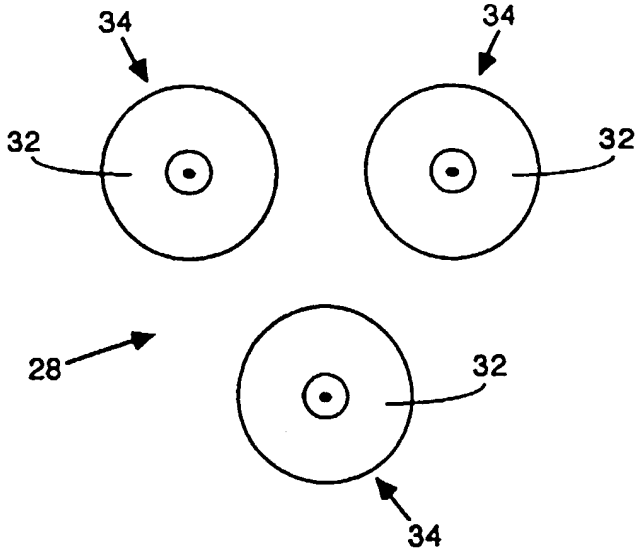

FIG. 5A

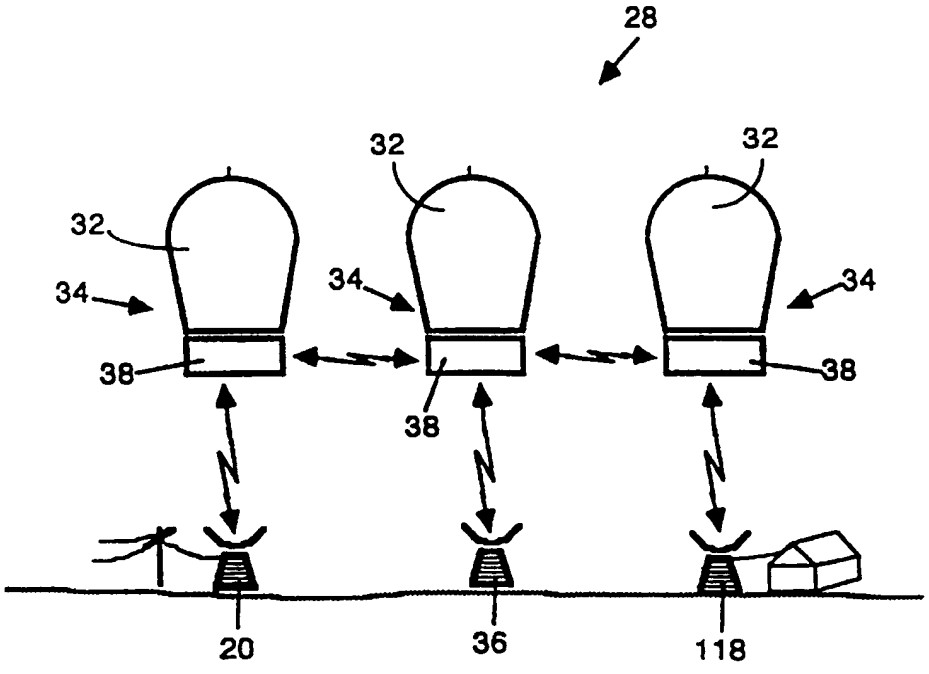

FIG. 5B

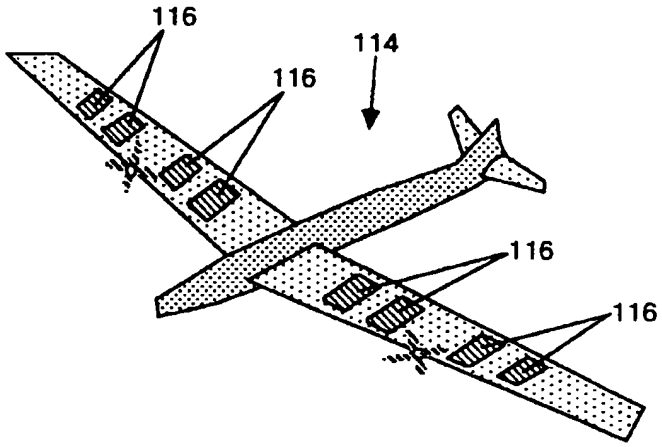

FIG. 6A

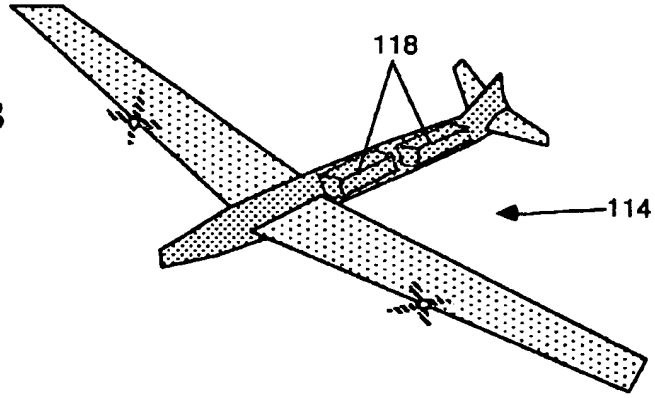

FIG. 6B

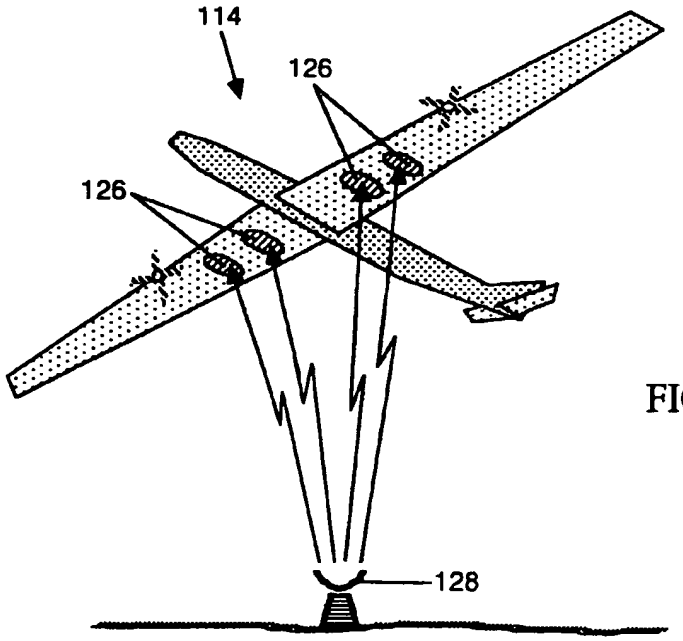

FIG. 6C

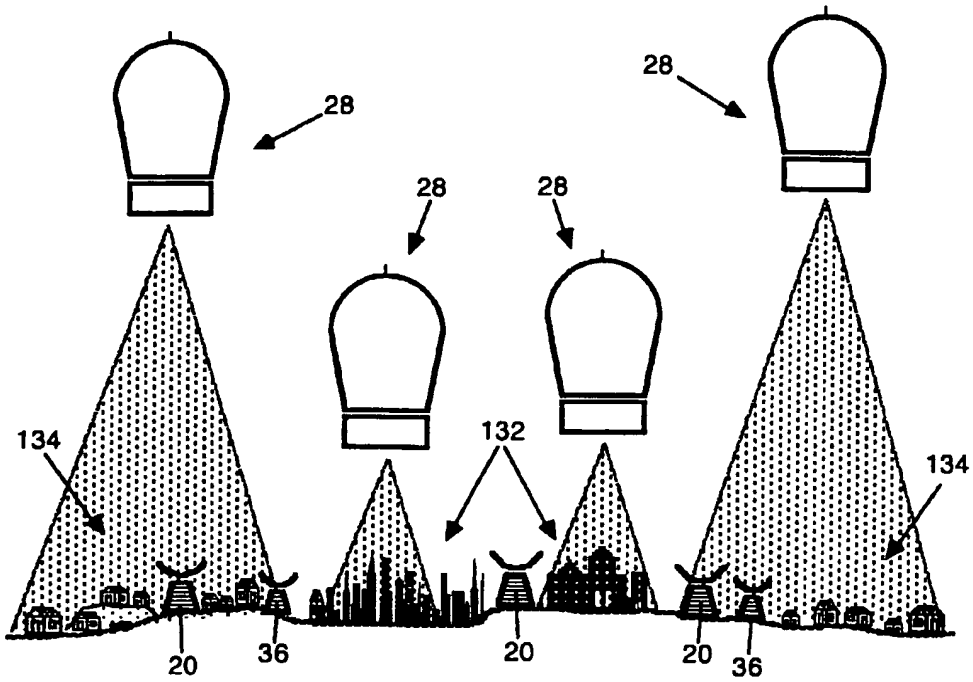
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FIG. 7A

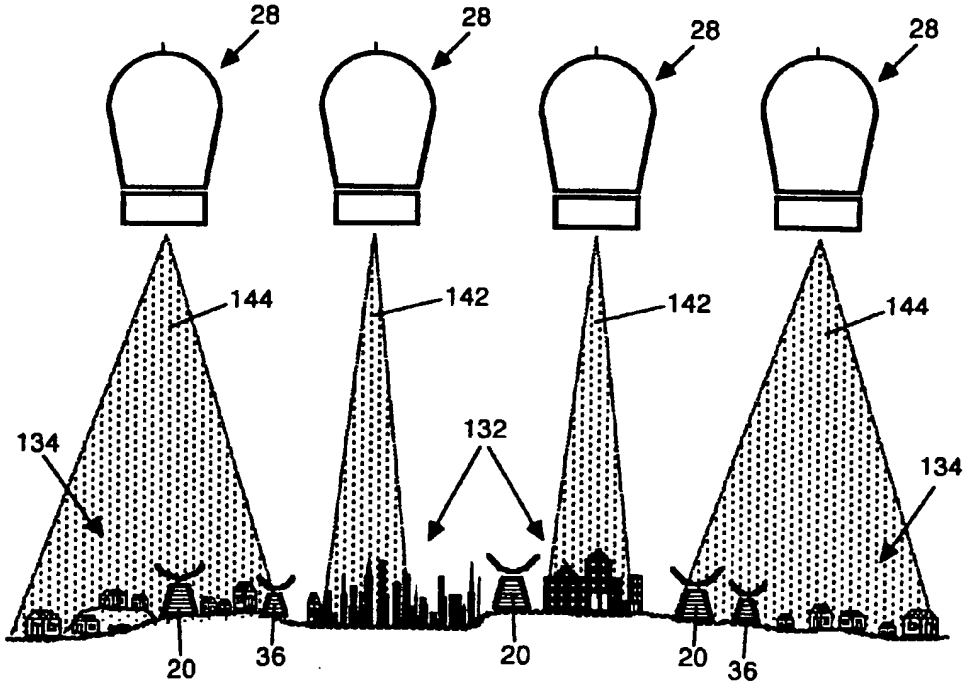
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FIG. 7B

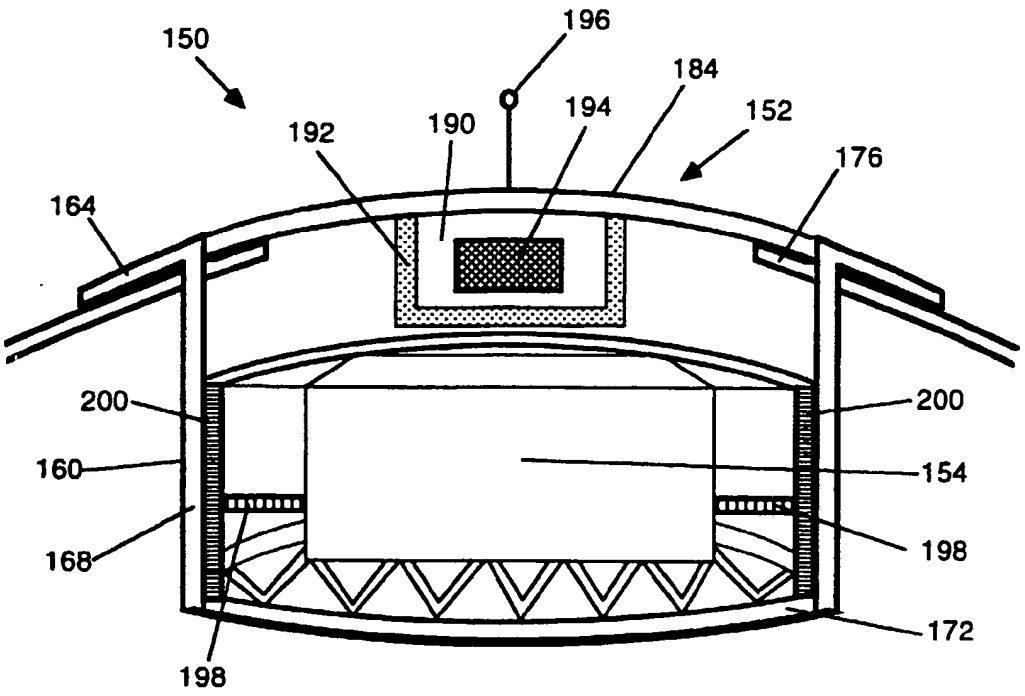
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FIG. 8

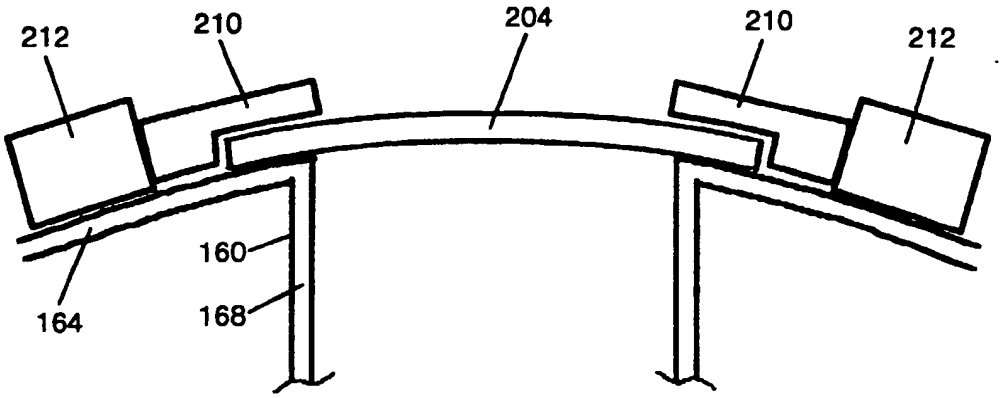
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FIG. 9

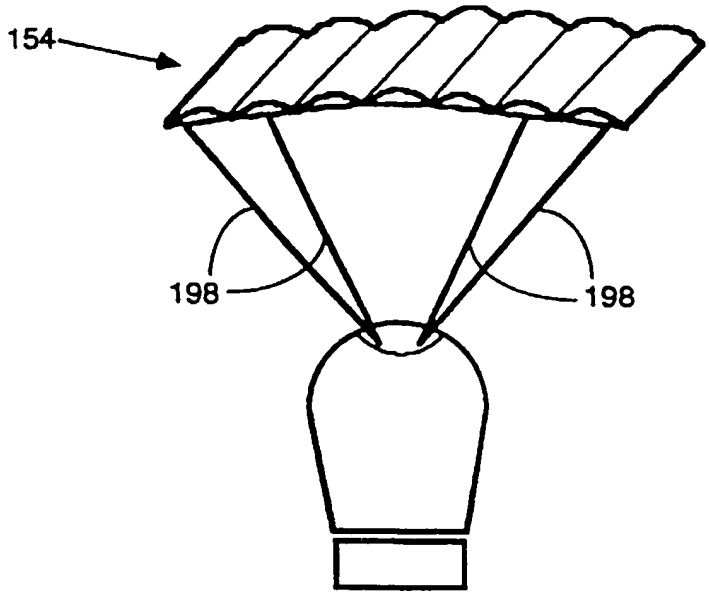

FIG. 10